WHAT IS CLAIMED IS:

1. A two-mode plasma containment apparatus, comprising:

a plasma disposed within a containment volume having a containment dimension, said plasma comprising a number of electrons and a number of ions, and wherein said electrons act as charge carriers in a current established in said plasma; and

a magnetic field that influences said electrons substantially more than said ions such that said electrons are magnetically confined as a first mode of confinement to an electron confinement volume that is smaller than said containment volume so as to cause at least a partial separation in distributions in said number of electrons and said number of ions, wherein said separation induces an electrostatic field that facilitates confinement of said ions as a second mode of confinement within said containment volume.

2. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 1000 electron skin depths.

3. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 100 electron skin depths.

4. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 60 electron skin depths.

5. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 40 electron skin depths.

6. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 10 electron skin depths.

7. The apparatus of Claim 1, wherein the electron confinement volume has a dimension in the range between approximately 1 to approximately 2 electron skin depths.

8. The apparatus of Claim 1, wherein the electron confinement volume has a dimension of approximately 1.2 electron skin depths.

9. The apparatus of Claim 1, wherein the containment volume is substantially cylindrical in shape.

10. The apparatus of Claim 1, wherein the containment volume is substantially toroidal in shape.

11. The apparatus of Claim 1, wherein the electrons are confined by the magnetic field using Z-pinch confinement.

12. The apparatus of Claim 1, wherein the electrons are confined by the magnetic field using theta-pinch confinement.

13. The apparatus of Claim 1, wherein the electrons are confined by the magnetic field using a combination of Z-pinch and theta-pinch confinement.

14. The apparatus of Claim 1, wherein operating parameters of the plasma are subject to a restriction in a beta value associated with the plasma, wherein the beta value depends on factors comprising average number density, temperature of the plasma, and strength of the magnetic field.

15. The apparatus of Claim 1, wherein a contribution of the electrons to the current is relatively more than a contribution of the ions to the current.

16. The apparatus of Claim 1, wherein a bulk motion of the electrons in the plasma is relatively more than a bulk motion of the ions in the plasma.

17. The apparatus of Claim 1, wherein a flow of the electrons in the plasma is relatively more than a flow of the ions in the plasma.

18. A plasma chamber, comprising:

a plasma comprising electrons and ions; and

a magnetic field having a shape and size that substantially confines said electrons within a restricted volume characterized by a volume scale length, said volume scale length having a size determined by an electron skin depth within said restricted volume, where said electrons and said ions are maintained in overlapping spatial distributions within said restricted volume, said overlapping spatial distributions generating a substantial bulk electrostatic field within said restricted volume that stabilizes said overlapping spatial distributions and confines said ions substantially within said restricted volume.

19. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 1000 electron skin depths.

20. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 100 electron skin depths.

21. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 60 electron skin depths.

22. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 40 electron skin depths.

23. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 10 electron skin depths.

24. The plasma chamber of Claim 18, wherein said volume scale length is in the range between approximately 1 to approximately 2 electron skin depths.

25. The plasma chamber of Claim 18, wherein said volume scale length is approximately 1.2 electron skin depths.

26. The plasma chamber of Claim 18, wherein said restricted volume is substantially cylindrical in shape.

27. The plasma chamber of Claim 18, wherein said restricted volume is substantially toroidal in shape.

28. The plasma chamber of Claim 18, wherein said electrons are confined by said magnetic field using Z-pinch containment.

29. The plasma chamber of Claim 18, wherein said electrons are confined by said magnetic field using theta-pinch containment.

30. The plasma chamber of Claim 18, wherein said electrons are confined by said magnetic field using a combination of Z-pinch and theta-pinch containment.

31. The plasma chamber of Claim 18, wherein operating parameters of the plasma are subject to a restriction in a beta value associated with the plasma, wherein the beta value depends on factors comprising average number density, temperature of the plasma, and strength of the magnetic field.

32. The plasma chamber of Claim 18, wherein the plasma is contained in a manner that allows fusion reaction of at least some of the ions.

33. The plasma chamber of Claim 32, wherein the fusion reaction generates neutrons.

34. The plasma chamber of Claim 32, wherein the fusion reaction generates power.

35. The plasma chamber of Claim 18, wherein the plasma is contained in a manner that allows production of soft x-rays.

36. The plasma chamber of Claim 18, wherein a contribution of the electrons to a current in the plasma is relatively more than a contribution of the ions to the current.

37. The plasma chamber of Claim 18, wherein a bulk motion of the electrons in the plasma is relatively more than a bulk motion of the ions in the plasma.

38. The plasma chamber of Claim 18, wherein a flow of the electrons in the plasma is relatively more than a flow of the ions in the plasma.

39. A method for designing a plasma confinement device, comprising:

generating a characterization of the energy of a plasma system comprising a distribution of electrons and a distribution of ions, wherein said characterization includes an energy term associated with a bulk electrostatic field induced inside the plasma by dissimilarities between said distribution of electrons and said distribution of ions;

determining an equilibrium state associated with said characterization of the energy of the plasma system; and

determining one or more plasma parameters associated with said equilibrium state.

40. The method of Claim 39, wherein said one or more plasma parameters comprises an electron number density and a volume scale length.

41. A plasma fusion device, comprising:

a plasma reaction chamber having a plasma confined therein, wherein the plasma comprises a number of electrons and a number of ions;

a confinement field generator that provides a magnetic field to the reaction chamber thereby facilitating confinement of the plasma substantially within a plasma confinement volume; and

a reaction fuel supply that provides one or more species of ions that can fuse under a plasma condition so as to yield a reaction product, wherein electrons act as charge carriers in a current established in the plasma thereby causing the magnetic field to influence the electrons more than the ions, such that magnetic confinement causes at least a partial separation in distributions in the number of electrons and the

number of ions, wherein such separation induces an electrostatic field that facilitates confinement of the ions within the plasma reaction chamber, and wherein the plasma confinement volume is characterized by a volume scale dimension.

42. The plasma fusion device of Claim 41, wherein the volume scale dimension is in the range between approximately 1 to approximately 1000 electron skin depths.

43. The plasma fusion device of Claim 41, wherein the volume scale dimension is in the range between approximately 1 to approximately 100 electron skin depths.

44. The plasma fusion device of Claim 41, wherein the volume scale dimension is in the range between approximately 1 to approximately 40 electron skin depths.

45. The plasma fusion device of Claim 41, wherein the volume scale dimension is in the range between approximately 1 to approximately 10 electron skin depths.

46. The plasma fusion device of Claim 41, wherein the volume scale dimension is approximately 3 electron skin depths.

47. The plasma fusion device of Claim 41, wherein the reaction product comprises neutrons such that the fusion device is used as a neutron generator.

48. The plasma fusion device of Claim 47, wherein the reaction fuel supply provides a deuterium-tritium fuel.

49. The plasma fusion device of Claim 48, wherein the deuterium-tritium plasma having an average density of approximately $10^{20}$ electrons per cubic meter allows the dimension to be less than approximately 1 cm.

50. The plasma fusion device of Claim 49, wherein the deuterium-tritium plasma having an average temperature of approximately 5 keV yields production of neutrons at a rate of approximately $10^{11}$ neutrons per second.

51. The plasma fusion device of Claim 41, wherein the reaction product comprises energy such that the fusion device is used as a power generator.

52. The plasma fusion device of Claim 51, wherein the power generator having the dimension less than approximately 40 cm generates power in the kilo-Watt range.

53. The plasma fusion device of Claim 41, wherein operating parameters of the plasma are subject to a restriction in a beta value associated with the plasma, wherein the beta value depends on factors comprising average number density, temperature of the plasma, and strength of the magnetic field.

54. The plasma fusion device of Claim 41, wherein a contribution of the electrons to the current in the plasma is relatively more than a contribution of the ions to the current.

55. The plasma fusion device of Claim 41, wherein a bulk motion of the electrons in the plasma is relatively more than a bulk motion of the ions in the plasma.

56. The plasma fusion device of Claim 41, wherein a flow of the electrons in the plasma is relatively more than a flow of the ions in the plasma.

57. An x-ray generator, comprising:

a plasma chamber having a plasma confined therein, wherein the plasma comprises a number of electrons and a number of ions; and

a confinement field generator that provides a magnetic field to the plasma chamber thereby facilitating confinement of the plasma substantially within a plasma confinement volume, wherein electrons act as charge carriers in a current established in the plasma thereby causing the magnetic field to influence the electrons more than the ions, such that magnetic confinement causes at least a partial separation in distributions in the number of electrons and the number of ions, wherein such separation induces an electrostatic field that facilitates confinement of the ions within the plasma chamber, and wherein the plasma confinement volume is characterized by a volume scale dimension.

58. The x-ray generator of Claim 57, wherein the volume scale dimension is in the range between approximately 1 to approximately 1000 electron skin depths.

59. The x-ray generator of Claim 57, wherein the volume scale dimension is in the range between approximately 1 to approximately 100 electron skin depths.

60. The x-ray generator of Claim 57, wherein the volume scale dimension is in the range between approximately 1 to approximately 40 electron skin depths.

61. The x-ray generator of Claim 57, wherein the volume scale dimension is in the range between approximately 1 to approximately 10 electron skin depths.

62. The x-ray generator of Claim 57, wherein the volume scale dimension is approximately 3 electron skin depths.

63. The x-ray generator of Claim 57, wherein the x-ray comprises a soft x-ray generated by the plasma under conditions including non-fusing conditions.

64. The x-ray generator of Claim 57, wherein operating parameters of the plasma are subject to a restriction in a beta value associated with the plasma, wherein the beta value depends on factors comprising average number density, temperature of the plasma, and strength of the magnetic field.

65. The x-ray generator of Claim 57, wherein a contribution of the electrons to the current in the plasma is relatively more than a contribution of the ions to the current.

66. The x-ray generator of Claim 57, wherein a bulk motion of the electrons in the plasma is relatively more than a bulk motion of the ions in the plasma.

67. The x-ray generator of Claim 57, wherein a flow of the electrons in the plasma is relatively more than a flow of the ions in the plasma.

68. A plasma containment apparatus, comprising:

a plasma disposed within a containment volume having a containment dimension, said plasma comprising a number of electrons and a number of ions, and wherein said ions act as charge carriers in a current established in said plasma; and

a magnetic field that influences said ions substantially more than said electrons such that said ions are magnetically confined to an ion confinement volume that is smaller than said containment volume so as to cause at least a partial separation in distributions in said number of ions and said number of electrons, wherein said separation induces an electrostatic field that facilitates confinement of said electrons within said containment volume.

69. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 1000 ion skin depths.

70. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 100 ion skin depths.

71. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 60 ion skin depths.

72. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 40 ion skin depths.

73. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 10 ion skin depths.

74. The apparatus of Claim 68, wherein the ion confinement volume has a dimension in the range between approximately 1 to approximately 2 ion skin depths.

75. The apparatus of Claim 68, wherein the ion confinement volume has a dimension of approximately 1.2 ion skin depths.

76. The apparatus of Claim 68, wherein the containment volume is substantially cylindrical in shape.

77. The apparatus of Claim 68, wherein the containment volume is substantially toroidal in shape.

78. The apparatus of Claim 68, wherein the ions are confined by the magnetic field using Z-pinch confinement.

79. The apparatus of Claim 68, wherein the ions are confined by the magnetic field using theta-pinch confinement.

80. The apparatus of Claim 68, wherein the ions are confined by the magnetic field using a combination of Z-pinch and theta-pinch confinement.

81. The apparatus of Claim 68, wherein operating parameters of the plasma are subject to a restriction in a beta value associated with the plasma, wherein the beta value depends on factors comprising average number density, temperature of the plasma, and strength of the magnetic field.

82. The apparatus of Claim 68, wherein a contribution of the ions to the current is relatively more than a contribution of the electrons to the current.

83. The apparatus of Claim 68, wherein a bulk motion of the ions in the plasma is relatively more than a bulk motion of the electrons in the plasma.

84. The apparatus of Claim 68, wherein a flow of the ions in the plasma is relatively more than a flow of the electrons in the plasma.

85. The apparatus of Claim 68, wherein the plasma is contained in a manner that allows fusion reaction of at least some of the ions.

86. The apparatus of Claim 85, wherein the fusion reaction generates neutrons.

87. The apparatus of Claim 85, wherein the fusion reaction generates power.

88. The apparatus of Claim 68, wherein the plasma is contained in a manner that allows production of soft x-rays.